

South Korea: Leveraging Renewable Energy and Air Filtration to Combat Air Pollution

Introduction

In South Korea, air pollution is a significant impediment that must be addressed. Air pollution impacts both the economy and human health. When humans breathe in polluted air it negatively affects the bodies. Therefore, humans are at grave risk of developing long standing health problems due to poor air quality.

Family Size and Diet

The typical family size consists of four individuals. The family composition is primarily a father, a mother, and two children. South Korea is a community-oriented nation, meaning apartment homes are widespread in South Korea. In South Korea, the various communities are very densely populated. Therefore, most food markets are within walking distance. Famous markets include Lotte Mart, E-mart, and Home Plus. A typical Korean diet consists of large portions of vegetables, fish, and small amounts of meat. One typical side dish is rice, which is put with every meal. In Korean culture, food is fermented, boiled, blanched, or pickled with seasoning. Some food and other items are purchased online; however, markets are preferred. The average wage for South Koreans is \$3,257 U.S. dollars per month. The average South Korean household income is approximately \$24,590 U.S. dollars annually.

College Education

South Korean colleges and universities are significantly cheaper than the United States of America. However, some South Korean families cannot afford to send their children to college. Most families pay for college through loans or household funding; if the family does not have a decent household income, it is hard for families to support funding university attendance. The hardship outlined is an increasing problem for struggling students attending four-year universities.

Governmental Levels

The South Korean government runs similarly to the United States of America as there are two levels of government, federal and state. "The National Assembly of the Republic of Korea is the unicameral national legislature of South Korea. The National Assembly makes all the laws of the country. Local governments are divided into high-level and low-level local governments. "

Population, Agriculture and Climate

Currently, South Korea has a population of 51,327,339 people. South Korea is heavily industrialized, meaning South Korea is majority urban rather than rural. The urban population percentage is 81.41%, while the rural population is 18.59%. In rural areas, land cultivation is 14.09%. The primary crops of South Korea include rice, barley, wheat, and fruits, such as tangerines and pears. The average farm size is approximately one hectare. One hectare is roughly about the size of the city of Manhattan, New York. The major food exports of South Korea are beef, fruit, corn, dairy products, and soybeans.

In the winter, it is frigid and long. The yearly climate consists of mild temperatures in spring. Heavy rain is standard from summer to fall and has mild temperatures.

Impact of Air Pollutants

Due to heavy rains, indoor mold is consistently an issue within the country. Indoor mold impacts the population by causing many allergies and respiratory illnesses. Additionally, air pollutants can make indoor mold more dangerous as they become contaminants within the mold composition. South Korean coal plants emit nitrates, black carbon, and mineral dust into the air and atmosphere. Nitrates are recurring natural chemicals found in groundwater and surface water.

Gasoline, diesel, and coal are frequent fuel particles that impact air quality. Chronic exposure to all fuel particles will put humans at risk. If fuel particles are not burned completely, the byproduct is black carbon. Extreme exposure to black carbon exposes one to bronchitis and chronic obstructive pulmonary disease. Polycyclic aromatic hydrocarbons (PAHs) or other chemicals can cover black carbon to intensify the impact of diseases. Polycyclic aromatic hydrocarbon exposure can induce cancer and damaged organs and create reproductive issues and abnormalities depending on the length of time of exposure.

Air pollution in South Korea continues to worsen. In 2019, South Korea ranked as the 26th most air polluted country. However, as of 2022, air pollution average levels are at 70 Air Quality Index (AQI), an improvement of eight points compared to 2019. Yecheon-dong, South Korea, has the poorest air quality of any city in South Korea. The air quality index is 158 AQI. Yecheon-dong is typically at a moderate rate; however, in 2022, air pollution increased, disproportionate to the overall country air pollution improvement. On the contrary, Yeongyanggun, South Korea, has a steady history of good air quality. Currently, Yeongyanggun has an air quality index of 17 AQI.

Early in the covid-19 pandemic, air quality improved due to declining in-vehicle use. The lack of carbon emissions in the atmosphere helped lower the pollution rate overall and, in some communities, where high pollution was reported. However, in 2022, air pollution levels are rising due to South Korea relying heavily on coal-fired power plants. The continued rise in carbon dioxide is due to coal use polluting the air. Coal-fired power plants emit large amounts of debris into the atmosphere. The prolonged use of coal-fired plants has been a significant factor in high-ranking air pollution.

Disease and Complications

Under the National Library of Medicine, an article titled "Effects of air pollution on human health and practical measures for prevention in Iran" talks about how air pollution can affect the human body and how it can affect someone with a pre-existing condition. "Long and short-term exposure to air suspended toxicants has a different toxicological impact on humans, including respiratory and cardiovascular diseases, neuropsychiatric complications, eye irritation, skin diseases, and long-term chronic diseases such as cancer. Several reports have revealed the direct association between exposure to poor air quality and an increased morbidity and mortality rate, mostly due to cardiovascular and respiratory diseases. In addition, air pollution is considered the major environmental risk factor in the incidence and progression of some diseases such as asthma, lung cancer, ventricular hypertrophy, Alzheimer's and Parkinson's diseases, psychological complications, autism, retinopathy, fetal growth, and low birth weight."

A study was completed to compare how people in different age groups with respiratory disorders are affected by air pollution. Depending on what is in the air, it can affect the mortality and morbidity of the illness. The study concludes that people who face respiratory disorders are

more likely to suffer from air pollution. In addition, the elderly struggle with chronic obstructive pulmonary disease (COPD). Chronic obstructive pulmonary disease is an incurable lung disease that makes breathing difficult due to mucus buildup and restricted airways. Chronic obstructive pulmonary disease has a higher chance of hospitalization. Therefore, it is essential to have excellent healthcare to combat the decline in air quality which worsens pre-existing respiratory conditions.

Increase in Air Pollutant-Related Deaths

With the simple, necessary act of breathing, many within the South Korean population are experiencing severe lung problems, and some have succumbed to death due to lung cancer. In 2017, the Korean Statistical Information Service noted that 17,980 deaths were due to lung cancer. In total, in 2017, there were 285,534 deaths in South Korea. Therefore, the percentage of deaths from lung cancer alone is .06%. The importance of this finding is alarming because, in 1990, 14,400 deaths were due to indoor and outdoor air pollution. An increase of 23.5% of deaths due to air pollutants is substantial in 27 years.

Healthcare in South Korea

Healthcare in South Korea is governmentally funded and available to all. To access, residents must apply and register for the Nation Health Insurance (NHI) within six months of living in South Korea. Medical checkups, general procedures, accidents, and prescription medication costs are benefits of the NHI. The resident pays approximately 20% of the medical cost; however, there is a sliding scale due to income status. Due to air pollution, many patients must receive specialized care to combat the ill effects experienced. From breathing treatments to surgical intervention, patients impacted by poor air quality have had to rely heavily on the healthcare system.

Iran: Another Country Impacted by Significant Air Pollution

Iran has air pollution levels that are considerably worse than South Korea; in Iran, the air quality level is 145 AQI. That level of air quality has a rating of “unhealthy for sensitive groups.” The air quality is highly harmful to breathe and can cause many health diseases.

To combat this dilemma, Iran has "shut down eight businesses and restricted the use of older trucks." Clean energy technologies are continuously encouraged to reduce air pollution. In addition, Iran implemented the Clean Air Conservation Action in July 2017 which enforces punishments and fines for industries that do not comply with the law.

There is a plan to construct zones in Tehran, Iran that will prohibit using personal cars, which, in turn, will aid the lowering of pollution. In schools, there has been a suggestion of starting school earlier to help students. Starting school earlier prevents students from dealing with winter air pollution. Winter is the most challenging season to face air pollution in Iran. These are a few ideas that are being considered to lower the air pollution in Iran.

Solutions Currently Implemented in South Korea: The Clean Air Conservation Act

According to Privacy Shield, in July 2016, the government announced closing ten 30-year-old coal-fired plants by 2025. In 2017, the Clean Air Conservation Act was put into motion; in 2019, the addition of stricter rules were added. The Clean Air Conservation Act addressed automobile emissions, financial incentives, clean energy technology and pollution control action plans.

The Clean Air Conservation Act now enforces ways for clean energy and decreasing the impact of coal on the environment. Another solution proposed was to move the outdoor coal facilities indoors. This effort is gaining traction and is to be formally initiated by 2024. Changing the location of the coal is a short-term goal which is not sustainable. This change leaves open the question, how can the impact of moving coal indoors be measured and does it have any significant benefits on the population.

Recommendation: Leverage Lessons from China

South Korea could benefit from implementing wind turbines as a major renewable energy source instead of coal. Other countries have successfully implemented wind turbines as a major energy source to meet the needs of a growing economy and population.

In China, air pollution is higher than in South Korea. However, China has begun addressing this issue with an operation called "Program For Result (PforR)". The Program For Result was created to finance China's Pollution Controls Action Plan and the 13th Five Action Plan. The World Bank states, "The program supported a commercial bank, Huaxia Bank, to provide financing for enterprises to reduce air pollutants and carbon emissions by increasing energy efficiency, investing in clean energy, and tightening air pollution controls." This means that the operation helped many areas that support China in embarking on programs and machinery to lower air pollution. The operation "reduced carbon dioxide emissions by an estimated 2.5 million tons a year, thereby contributing to blue skies in the Jing-Jin-Ji region and China's efforts to mitigate climate change." The World Bank funds the Program For Result; other contributors are The International Bank for Reconstruction and Development (IBRD) and The Global Environmental Facility (GEF). The PforR is already a sustainable project. The results include 27 financed programs involving energy efficiency, renewable energy, and emission control. PforR helped shorten coal use by improving energy-efficient building sectors, which increased renewable energy supply. South Korea can leverage the results from the program to further the air pollution reduction efforts, especially the coal reduction efforts.

Recommendation: Harness Hydroelectric Energy

South Korea is surrounded on three sides by bodies of water. Therefore, the use of hydroelectric energy as a renewable energy source is a realistic and easily applicable option. Hydroelectric energy is energy gained from the continuous movement of water. This clean energy option is reusable and plentiful. Constructing and building infrastructure to harness hydropower can be learned by appointing South Korean delegates to work with the United States of America energy leaders to gain insights into the inner workings of leveraging hydroelectric power in industrial and residential settings. The United States of America is the fourth highest country to utilize hydroelectric power to aid the population and reduce the carbon footprint.

Recommendation: Harness Solar Energy

Solar power is a renewable energy source that is harnessed from the sun. One recommendation is that South Korea can create solar panel parks in each of the eight provinces to provide electricity and clean energy to businesses and the urban and rural populations. The solar panel parks can replace many of the coal-fired plants which directly impact air quality. The solar panel parks can also be used to provide new electricity options to rural areas that currently do not receive electricity. Lastly, the government can incentivize businesses and residents to lease solar panels from the government owned solar panel parks to offset the funding lost by retiring coal-fired plants. Lastly, similar to the United States of America, residents and

businesses can receive a government identified credit for leasing solar panels. The credit recommendation is a credit to offset the 20% deductible required for healthcare.

Solar paneling goes in tandem with solar batteries. Solar batteries can be leveraged in various parts of the country. Rural communities that have limited electricity can leverage solar batteries for lighting and running machinery and equipment. In addition, solar batteries can be retrofitted into cars already in use. However, a recommendation is that cars that run on fossil fuel can be required to be phased out of usage by 2031. If a mandate was put in place to change the fuel used for vehicles to solar batteries, this can have a major impact on the air quality.

Recommendation: HEPA Air Filtration

Air filters are a beneficial and affordable option to clean the air. In-home air systems filters can collect and trap all particulate matter, including black carbon. High-efficiency particulate air (HEPA) removes 99.97% of germs. An immediate recommendation is that every household be issued four HEPA air filter systems to counteract the high air pollution in the home in South Korea. For residents, the government should send out HEPA replacement air filters on a quarterly basis. In addition, large businesses should receive discounted rates to buy and install large air filtration systems. Smaller businesses should be issued four HEPA air filter systems with a discounted option to purchase more.

In May of 2022, The Korean Institute of Technology created a solution to eliminating the bacteria collected on HEPA filters. The Korean Institute of Technology created photothermal-based HEPA filters. Photothermal-based HEPA filters were made by radiating with light-emitting diodes on the visible light band. Which killed the bacteria cells. HEPA air filters can be a solution that works with other renewable solutions. These filters can be used as the initial and replacement filters within the home and business air filtration systems.

Recommendation: Plant Filtration

Some plants have leaves that trap and contain air particles significantly better than others. According to the Rural Developmental Administration in South Korea, lemon cypress, staghorn fern, sago palm, spear flower, and the money tree effectively contain fine dust particles. The money tree is the most effective out of the six plants listed. One recommendation is that the money tree be planted widely in each of the eight provinces in both urban and rural areas. In addition, the plant can be advertised on local programming and sold by the government to the residents at a significantly discounted price. The advertisement will incentivize residents to purchase the plant and have it within their homes. In addition, the government should also allocate free options for residents that make less than the average household income. This effort will ensure that all residents have the option to have this plant within their homes. Using plants as a renewable source is a viable and low cost solution to aid in improving air quality.

Conclusion

Air pollution is a major issue within South Korea that directly impacts the population and the economy. Implementing realistic and innovative solutions to address this issue is of great importance. If the country leverages the recommendations outlined above, a huge impact can be made to lower the IQAir ranking of South Korea as the 26th most polluted country. Hydroelectric energy and solar energy are abundant, renewable and viable options with many benefits for the country. HEPA air filtration and plant filtration are renewable sources that can be used to trap fine dust particles, including black carbon. In conclusion, implementing these

various solutions will help decrease carbon emissions, improve overall air quality and ultimately create a better quality of life for the residents of South Korea.

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